NATIBO TECHNOLOGY INSERTION PROJECT ION IMPLANTATION OF MILITARY COMPONENTS

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OBJECTIVE: To demonstrate and validate ion implantation as a viable process for improving the corrosion resistance and wearability of military components through performance of a test and evaluation program

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METALLURGICAL APPLICATIONS OF ION IMPLANTATION: BACKGROUND

- Basic and applied research in 1970's and early 1980's
  - Demonstrated improved corrosion and wear resistance in laboratory experiments and simulated operational tests
  - No impact on fatigue; no adhesion issues
- NRL implanted jet engine bearing components in 1981; installed on operational aircraft; tracking system inadequate
- **Navy Manufacturing Technology Project 1982-1986**
  - Developed large ion implantation system capable of treating actual aircraft parts using metal or gaseous ions
  - Navy jet engine components treated but non installed
- Preliminary cost/benefit analysis indicated favorable return for dedicated production system on high value components
- Army implanted T-53 engine bearings in 1990 using Navy ManTech implanter; successful 150 hour engine test completed; unable to obtain approval for flight testing
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SUMMARY OF TASKS

- Fabrication of test coupons for corrosion, wear, and fatigue tests
- Surface preparation and ion implantation of test coupons
- Performance of corrosion, wear, and fatigue tests
- Design and fabrication of fixturing for mounting components in ion implantation systems
- Ion implantation of components
- Quality control characterization of components
- Field testing of components

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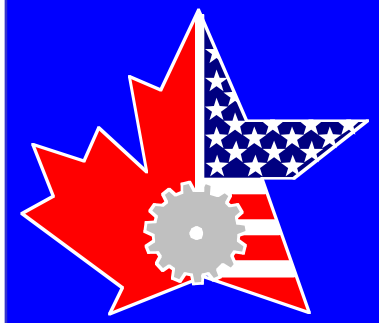
COUPON TESTING

- Ion Implantation
  - Chromium ions in best vacuum
  - Tantalum ions in partial pressure of reactive oxygen
  - Nitrogen ions
- Corrosion testing
  - Nine test coupons of 4140 and 52100 steel
  - Three each receive Cr and Ta II; three baseline
  - Conduct GM cyclic corrosion test
- Fatigue testing
  - Eighteen 52100 test rods for rolling contact fatigue tests
  - Six each receive Cr and Ta II; six baseline
- Wear testing
  - Six hard-Cr-plated 4340 test rods
  - Four implanted with N; two baseline
  - Falex wear tests conducted



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MILESTONES FOR COUPON TESTING

Identify test parameters	February 1998
Fabricate test coupons	March-April 1998
Conduct ion implantation of coupons	May-June 1998
Complete corrosion testing	September 1998
Complete wear testing	October 1998
Complete fatigue testing	December 1998

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COMPONENTS FOR TECHNOLOGY INSERTION

I. Worm gear from the elevation mechanism on the Marine Corps Amphibious Assault Vehicle

II. Planetary transmission gear from the Navy CH-46 helicopter

III. Power steering pump from the Army CH-47 helicopter

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AAV ELEVATION MECHANISM

- Problem: Corrosion causes elevation mechanism to seize, resulting in removal for repair or replacement
- Item Cost: $6000
- Treatment Strategy: Metal ion implantation
  - Chromium ions in best vacuum
  - Tantalum ions in partial pressure of reactive oxygen
- Anticipated Benefit:
  - Enhanced corrosion resistance
  - Reduced maintenance costs
  - Improve operational readiness

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AAV ELEVATION MECHANISM MILESTONES

Obtain AAV components	October 1997
Strip black coating	November 1997
Deliver to Implant Sciences	January 1998
Construct fixturing	February 1998
Conduct ion implantation	March 1998
Deliver components to Marine Corps	March 1998
Operational test in AAV's	May 1998
Remove components for evaluation	September 1998

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CH46 HELICOPTER COMPONENT PLANETARY GEAR AND BEARING

- Function: Transmit power from engine to rotor head
- Problem: Excessive general and pitting corrosion resulting in premature rejection and replacement during overhaul
- Usage Rage: Average of 30 per month rejected; more than 80% due to corrosion
- Item Cost: $2,000; Annual cost: $700,000
- Treatment strategy (utilize Navy ManTech ion implanter):
  - Chromium ion implantation in high vacuum
  - Tantalum ion implantation in partial oxygen pressure
- Anticipated benefit:
  - Significantly increased resistance to general and pitting corrosion
  - Reduced maintenance and acquisition costs

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CH46 PLANETARY TRANSMISSION GEAR AND BEARING

- Five units on each helicopter
- Located in transmission
- Transmits power from engine to rotor head
- Photograph shows inner ring of bearing with excessive general and pitting corrosion

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CH47 HELICOPTER COMPONENT POWER STEERING PUMP

- Function: Power steering component
- Problem: Excessive wear of Cr electroplate; premature failure
- Usage Rate: Average of XX per month rejected; requires costly remachining
- Item Cost: $3700; more than 30% rejected due to wear
- Treatment Strategy (Utilize Navy Man Tech Ion Implanter):
  - Nitrogen Ion Implantation
- Anticipated Benefit:
  - Increased wear resistance
  - Reduced machining costs
  - Reduced waste stream

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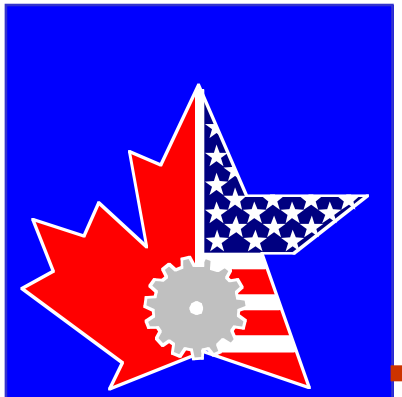
CH47 HELICOPTER COMPONENT POWER STEERING PUMP

- One unit on each helicopter
- Unit experiences excessive wear due to ???
- Photograph shows Cr plated component receiving wear



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CH47 HELICOPTER COMPONENT MILESTONES

• Obtain steering pump assemblies [CCAD]	March 98
• Construct fixturing	March 98
• Conduct N ion implantation	April-May 98
• Install on CH47 helicopters	June-Sept 98
• Evaluate components during overhaul	August 99